

GCSE MATHEMATICS

HIGHER TIER

COMPREHENSIVE LESSON NOTEBOOK

UNIT 7 | MENSURATION

TEACH-FROM-SCRATCH • PUBLICATION EDITION

10 detailed chapters • original diagrams • worked examples • guided practice • answers

INDEPENDENT PUBLICATION NOTICE

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COMPREHENSIVE LESSON NOTEBOOK

How to learn from this notebook

Meaning first. Method second. Practice third.

FIVE-PASS ROUTINE

1 Read the key idea without a calculator. 2 Cover each worked solution and reproduce it. 3 Complete practice independently. 4 Mark in a different colour and repair errors. 5 Retest after 2–7 days.

What a complete mathematics answer contains

- A clear model or calculation, not only a calculator display.
- Enough working for another person to follow the reasoning.
- Exact values until approximation is requested.
- Units and sensible rounding in context.
- A final statement when interpretation is required.

Error loop

REPAIR, DO NOT MERELY CORRECT

Label each error: concept, operation, arithmetic, calculator entry, accuracy, unit or interpretation. Write the corrected step and one sentence explaining the change.

Higher mensuration requires connected spatial reasoning

OCR Higher mensuration connects units, exact geometry, 3D modelling and non-right-angled trigonometry. Strong performance depends on selecting the correct cross-section and preserving exact values.

COMPREHENSIVE LESSON NOTEBOOK

Unit 7 coverage map

OCR J560 Mensuration content organised into a teachable sequence.

CH 01	OCR 10.01a	Units and measurement
CH 02	OCR 10.01b-10.01c	Compound units, maps and scales
CH 03	OCR 10.02a-10.02c	Perimeter and compound boundaries
CH 04	OCR 10.03a-10.03c; 10.03e	Area of polygons and compound shapes
CH 05	OCR 10.02b; 10.03d	Circles, arcs and sectors
CH 06	OCR 10.04a	Prisms and volume
CH 07	OCR 10.04a	Surface area and nets
CH 08	OCR 10.04b-10.04c	Cones, spheres and pyramids
CH 09	OCR 10.05a-10.05c	3D Pythagoras and trigonometry
CH 10	OCR 10.05d-10.05e	Sine rule, cosine rule and mixed triangles
IMPORTANT TIER NOTE This notebook covers OCR J560 section 10 at Higher Tier: measurement, scale, perimeter, area, circles, solids, Pythagoras and right-angle trigonometry. Specification references are identifiers, not copied specification wording.		

COMPREHENSIVE LESSON NOTEBOOK

Fast-reference method bank

Understand each relationship before memorising it.

Speed

distance/time

Density

mass/volume

Pressure

force/area

Arc length

$\theta/360 \times 2\pi r$

Sector area

$\theta/360 \times \pi r^2$

Prism volume

cross-section area $\times$ length

Cone / sphere

$V = \frac{1}{3}\pi r^2 h$; $V = \frac{4}{3}\pi r^3$

Pythagoras

$a^2 + b^2 = c^2$

Sine rule

$a/\sin A = b/\sin B = c/\sin C$

Cosine rule

$a^2 = b^2 + c^2 - 2bc \cos A$

CURRENT ASSESSMENT NOTE

OCR has announced Foundation and Higher formula sheets for GCSE Mathematics examinations in 2025, 2026 and 2027. Use the current official OCR sheet alongside this learning bank and check OCR for later exam-series arrangements.

COMPREHENSIVE LESSON NOTEBOOK

Units and measurement

Convert length, area, volume, capacity, mass and time units.

SPECIFICATION FOCUS

OCR reference OCR 10.01a. This lesson develops representation, accurate calculation, reasoning and interpretation within Higher Tier.

Understand the idea

Units describe what is measured. Linear, square and cubic measures scale differently, so conversion factors must match dimension.

KEY VOCABULARY

metric unit • length • area • volume • capacity • precision

$$1 \text{ m} = 100 \text{ cm} \quad \bullet \quad 1 \text{ m}^2 = 10,000 \text{ cm}^2$$

linear factor 100 • area factor 100²

Why the method works

- The formula follows from the geometric structure or defining rate.
- Units track the type and scale of the result.
- An estimate or inverse calculation provides an independent check.

CHECK BEFORE MOVING ON

Answer mentally: Convert 3.7 m² to mm². Then define one key word from this page in your own words.

COMPREHENSIVE LESSON NOTEBOOK

Units and measurement — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Write the conversion factor.
- For area square the length factor; for volume cube it.
- Convert before substituting into a formula.

WORKED EXAMPLE 1

Convert 3.7 m^2 to mm^2 .

SOLUTION

1. $1 \text{ m} = 1000 \text{ mm}$.
2. Square the conversion: $1 \text{ m}^2 = 10^6 \text{ mm}^2$.
3. Multiply 3.7 by 10^6 .

ANSWER: $3,700,000 \text{ mm}^2$

WORKED EXAMPLE 2

A cube has volume 0.064 m^3 . Find its side length in cm.

SOLUTION

1. Cube root $0.064 = 0.4 \text{ m}$.
2. Convert to 40 cm.

ANSWER: 40 cm

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes a solution easier to repair.

COMPREHENSIVE LESSON NOTEBOOK

Units and measurement — apply and reason

Connect the method to decisions and common errors.

Where this mathematics appears

Construction, science and everyday measurement require reliable conversions.

Common misconceptions

- Using incompatible units.
- Selecting a visually familiar but incorrect formula.
- Rounding before the final step or omitting units.

GUIDED TRY

Convert 2.4 m^2 to cm^2 . First predict the form or approximate size of the answer. Then show the complete method.

REASONING PROMPT

A speed is 17.5 m/s . Convert to km/h . Explain why each condition or operation you use is valid.

EXAM COMMUNICATION

Use one mathematical statement per line. Label units and restrictions. If the result is approximate, show the unrounded value before the final rounded answer.

COMPREHENSIVE LESSON NOTEBOOK

Independent practice

Units and measurement

Complete without notes. Show all working, then use the answer section to diagnose and repair errors.

1. Convert 3.7 m^2 to mm^2 .

[4]

2. A cube has volume 0.064 m^3 . Find its side length in cm.

[4]

3. Convert 2.4 m^2 to cm^2 .

[2]

4. Convert 0.035 m^3 to litres.

[2]

5. Convert 2.75 kg to grams.

[1]

6. Convert 2 h 45 min to minutes.

[2]

7. Convert 2.85 g/cm^3 to kg/m^3 .

[5]

SHOW ALL WORKING

8. A speed is 17.5 m/s . Convert to km/h .

[3]

REFLECTION

Circle one: secure / almost / reteach. Record the question number of your most useful error and the rule that repairs it.

COMPREHENSIVE LESSON NOTEBOOK

Compound units, maps and scales

Use rates and scale factors with consistent units.

SPECIFICATION FOCUS

OCR reference OCR 10.01b-10.01c. This lesson develops representation, accurate calculation, reasoning and interpretation within Higher Tier.

Understand the idea

Compound units compare quantities. A scale drawing uses one constant linear ratio, while rates arise from division with meaningful units.

KEY VOCABULARY

speed • density • flow rate • scale drawing • map ratio

drawing

real = drawing × scale

Why the method works

- The formula follows from the geometric structure or defining rate.
- Units track the type and scale of the result.
- An estimate or inverse calculation provides an independent check.

CHECK BEFORE MOVING ON

Answer mentally: A car travels 186 km in 2 h 15 min. Find average speed in m/s. Then define one key word from this page in your own words.

COMPREHENSIVE LESSON NOTEBOOK

Compound units, maps and scales — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Use $\text{speed} = \text{distance} / \text{time}$ and $\text{density} = \text{mass} / \text{volume}$.
- Convert units before dividing.
- For scale 1:n, multiply drawing length by n.

WORKED EXAMPLE 1

A car travels 186 km in 2 h 15 min. Find average speed in m/s.

SOLUTION

1. Time = 2.25 h.
2. Speed = $82.666\dots$ km/h.
3. Divide by 3.6.

ANSWER: 22.96 m/s

WORKED EXAMPLE 2

A metal block 12 cm by 8 cm by 5 cm has mass 3.744 kg. Find density in g/cm^3 .

SOLUTION

1. Volume = 480 cm^3 .
2. Mass = 3744 g.
3. Density = $3744 / 480$.

ANSWER: 7.8 g/cm^3

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes a solution easier to repair.

COMPREHENSIVE LESSON NOTEBOOK

Compound units, maps and scales — apply and reason

Connect the method to decisions and common errors.

Where this mathematics appears

Travel, materials and maps depend on rates and scale.

Common misconceptions

- Using incompatible units.
- Selecting a visually familiar but incorrect formula.
- Rounding before the final step or omitting units.

GUIDED TRY

A map scale is 1:50,000. What does 4 cm represent? First predict the form or approximate size of the answer. Then show the complete method.

REASONING PROMPT

A force 3.6 kN acts on 24 cm². Find pressure in Pa. Explain why each condition or operation you use is valid.

EXAM COMMUNICATION

Use one mathematical statement per line. Label units and restrictions. If the result is approximate, show the unrounded value before the final rounded answer.

COMPREHENSIVE LESSON NOTEBOOK

Independent practice

Compound units, maps and scales

Complete without notes. Show all working, then use the answer section to diagnose and repair errors.

1. A car travels 186 km in 2 h 15 min. Find average speed in m/s.

[5]

SHOW ALL WORKING

2. A metal block 12 cm by 8 cm by 5 cm has mass 3.744 kg. Find density in g/cm³.

[5]

SHOW ALL WORKING

3. A map scale is 1:50,000. What does 4 cm represent?

[3]

4. A car travels 72 km/h for 25 min. Find distance.

[3]

5. Flow rate is 18 L/min for 7.5 min. Find volume.

[2]

6. A real wall 12 m is 8 cm on a plan. Find scale.

[3]

7. A map scale is 1:25,000. An area is 18 cm² on map. Find real area in hectares.

[5]

SHOW ALL WORKING

8. A force 3.6 kN acts on 24 cm². Find pressure in Pa.

[5]

SHOW ALL WORKING

REFLECTION

Circle one: secure / almost / reteach. Record the question number of your most useful error and the rule that repairs it.

COMPREHENSIVE LESSON NOTEBOOK

Perimeter and compound boundaries

Find rectilinear, circular and composite boundary lengths without counting internal edges.

SPECIFICATION FOCUS

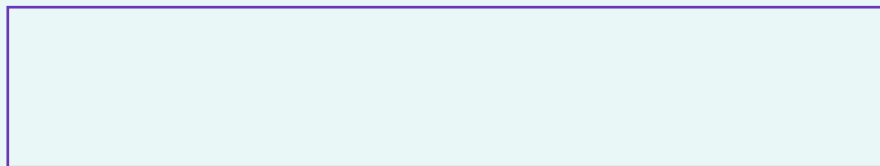
OCR reference OCR 10.02a-10.02c. This lesson develops representation, accurate calculation, reasoning and interpretation within Higher Tier.

Understand the idea

Perimeter is total distance around the outside. Internal edges are excluded and curved boundaries require circumference or arc length.

KEY VOCABULARY

perimeter • boundary • exposed edge • regular • semicircle



trace the outside boundary once

Why the method works

- The formula follows from the geometric structure or defining rate.
- Units track the type and scale of the result.
- An estimate or inverse calculation provides an independent check.

CHECK BEFORE MOVING ON

Answer mentally: A stadium track consists of two semicircles radius 36.5 m and two straights 84.4 m. Find perimeter. Then define one key word from this page in your own words.

COMPREHENSIVE LESSON NOTEBOOK

Perimeter and compound boundaries — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Trace the outside boundary once.
- Find missing lengths from aligned totals.
- Add only exposed edges and include units.

WORKED EXAMPLE 1

A stadium track consists of two semicircles radius 36.5 m and two straights 84.4 m. Find perimeter.

SOLUTION

- Two semicircles form one circle.
- Perimeter = $2\pi(36.5) + 2(84.4)$.

ANSWER: about 398.1 m

WORKED EXAMPLE 2

A sector radius 12 cm has perimeter 39 cm. Find its angle.

SOLUTION

- Arc length = $39 - 24 = 15$ cm.
- $15 = (\theta/360)2\pi(12)$.
- Solve θ .

ANSWER: about 71.6°

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes a solution easier to repair.

COMPREHENSIVE LESSON NOTEBOOK

Perimeter and compound boundaries — apply and reason

Connect the method to decisions and common errors.

Where this mathematics appears

Fencing, edging and frames are perimeter applications.

Common misconceptions

- Using incompatible units.
- Selecting a visually familiar but incorrect formula.
- Rounding before the final step or omitting units.

GUIDED TRY

Triangle sides are 7.2, 8.5, 10.1 cm. Find perimeter. First predict the form or approximate size of the answer. Then show the complete method.

REASONING PROMPT

A wheel radius 0.42 m turns 850 times. Find distance in km. Explain why each condition or operation you use is valid.

EXAM COMMUNICATION

Use one mathematical statement per line. Label units and restrictions. If the result is approximate, show the unrounded value before the final rounded answer.

COMPREHENSIVE LESSON NOTEBOOK

Independent practice

Perimeter and compound boundaries

Complete without notes. Show all working, then use the answer section to diagnose and repair errors.

1. A stadium track consists of two semicircles radius 36.5 m and two straights 84.4 m. Find perimeter.

[4]

2. A sector radius 12 cm has perimeter 39 cm. Find its angle.

[5]

SHOW ALL WORKING

3. Triangle sides are 7.2, 8.5, 10.1 cm. Find perimeter.

[2]

4. An L-shape comes from 10×8 rectangle with 4×3 corner removed. Find perimeter.

[3]

5. A regular hexagon side is 6.5 cm. Find perimeter.

[2]

6. A semicircle has diameter 10 cm. Find total perimeter to 1 d.p.

[3]

7. A regular hexagon side 9 cm is combined with a semicircle on one side. Find external perimeter.

[4]

8. A wheel radius 0.42 m turns 850 times. Find distance in km.

[4]

REFLECTION

Circle one: secure / almost / reteach. Record the question number of your most useful error and the rule that repairs it.

COMPREHENSIVE LESSON NOTEBOOK

Area of polygons and compound shapes

Calculate triangle, parallelogram, trapezium and composite areas.

SPECIFICATION FOCUS

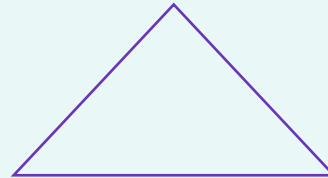
OCR reference OCR 10.03a-10.03c; 10.03e. This lesson develops representation, accurate calculation, reasoning and interpretation within Higher Tier.

Understand the idea

Area measures enclosed surface. Compound regions can be partitioned or found by subtraction without overlaps or gaps.

KEY VOCABULARY

area • perpendicular height • compound shape • cut-out • tessellation



Why the method works

- The formula follows from the geometric structure or defining rate.
- Units track the type and scale of the result.
- An estimate or inverse calculation provides an independent check.

CHECK BEFORE MOVING ON

Answer mentally: Find area of triangle with sides 9 cm and 14 cm and included angle 38° . Then define one key word from this page in your own words.

COMPREHENSIVE LESSON NOTEBOOK

Area of polygons and compound shapes — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Choose the formula that matches the perpendicular dimensions.
- Split compound shapes into non-overlapping parts.
- Subtract cut-outs only after finding both areas.

WORKED EXAMPLE 1

Find area of triangle with sides 9 cm and 14 cm and included angle 38° .

SOLUTION

1. Use $\frac{1}{2} ab \sin C$.
2. $0.5 \times 9 \times 14 \times \sin 38^\circ$.

ANSWER: about 38.8 cm^2

WORKED EXAMPLE 2

A trapezium area is 156 cm^2 , parallel sides 9 and 17 cm. Find perpendicular height.

SOLUTION

1. $156 = \frac{1}{2}(26)h$.
2. $13h = 156$.

ANSWER: 12 cm

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes a solution easier to repair.

COMPREHENSIVE LESSON NOTEBOOK

Area of polygons and compound shapes — apply and reason

Connect the method to decisions and common errors.

Where this mathematics appears

Flooring, painting and land measurement use area.

Common misconceptions

- Using incompatible units.
- Selecting a visually familiar but incorrect formula.
- Rounding before the final step or omitting units.

GUIDED TRY

Find parallelogram area base 11 cm, height 4.5 cm. First predict the form or approximate size of the answer. Then show the complete method.

REASONING PROMPT

A regular hexagon has side 8 cm. Find exact area. Explain why each condition or operation you use is valid.

EXAM COMMUNICATION

Use one mathematical statement per line. Label units and restrictions. If the result is approximate, show the unrounded value before the final rounded answer.

COMPREHENSIVE LESSON NOTEBOOK

Independent practice

Area of polygons and compound shapes

Complete without notes. Show all working, then use the answer section to diagnose and repair errors.

1. Find area of triangle with sides 9 cm and 14 cm and included angle 38° .

[4]

2. A trapezium area is 156 cm^2 , parallel sides 9 and 17 cm. Find perpendicular height.

[4]

3. Find parallelogram area base 11 cm, height 4.5 cm.

[2]

4. Find trapezium area with parallel sides 8 and 14 cm, height 5 cm.

[3]

5. A 10×8 rectangle has 3×2 cut-out. Find remaining area.

[2]

6. A triangle area is 48 cm^2 and base 12 cm. Find height.

[3]

7. A square of side 14 cm contains four quarter-circles radius 7 cm at corners. Find uncovered area.

[4]

8. A regular hexagon has side 8 cm. Find exact area.

[5]

SHOW ALL WORKING

REFLECTION

Circle one: secure / almost / reteach. Record the question number of your most useful error and the rule that repairs it.

COMPREHENSIVE LESSON NOTEBOOK

Circles, arcs and sectors

Use radius, diameter and fractions of a full circle.

SPECIFICATION FOCUS

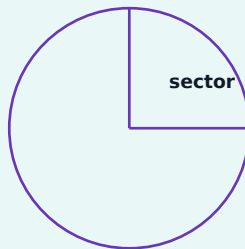
OCR reference OCR 10.02b; 10.03d. This lesson develops representation, accurate calculation, reasoning and interpretation within Higher Tier.

Understand the idea

Circle measures are built from radius and π . Sectors are fractions of a full 360° circle; perimeter and area require different boundaries.

KEY VOCABULARY

radius • diameter • circumference • sector • arc



Why the method works

- The formula follows from the geometric structure or defining rate.
- Units track the type and scale of the result.
- An estimate or inverse calculation provides an independent check.

CHECK BEFORE MOVING ON

Answer mentally: A sector radius 15 cm has area $75\pi \text{ cm}^2$. Find angle and arc length. Then define one key word from this page in your own words.

COMPREHENSIVE LESSON NOTEBOOK

Circles, arcs and sectors — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Use $C=2\pi r=\pi d$ and $A=\pi r^2$.
- For sectors and arcs multiply by angle/360.
- Keep π until the final rounding step.

WORKED EXAMPLE 1

A sector radius 15 cm has area $75\pi \text{ cm}^2$. Find angle and arc length.

SOLUTION

1. $\theta/360 \times 225\pi = 75\pi$ gives $\theta=120$.
2. Arc $=120/360 \times 30\pi$.

ANSWER: 120° and $10\pi \text{ cm}$

WORKED EXAMPLE 2

A chord subtends 90° at centre of circle radius 8 cm. Find minor segment area.

SOLUTION

1. Sector area $=90/360 \times 64\pi=16\pi$.
2. Triangle area $=1/2 \times 8 \times 8=32$.
3. Subtract.

ANSWER: $16\pi-32 \text{ cm}^2$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes a solution easier to repair.

COMPREHENSIVE LESSON NOTEBOOK

Circles, arcs and sectors — apply and reason

Connect the method to decisions and common errors.

Where this mathematics appears

Wheels, dials and circular design use circle measures.

Common misconceptions

- Using incompatible units.
- Selecting a visually familiar but incorrect formula.
- Rounding before the final step or omitting units.

GUIDED TRY

Find arc length of a 90° sector radius 8 cm. First predict the form or approximate size of the answer. Then show the complete method.

REASONING PROMPT

A sector arc length is 6π and angle 135° . Find radius. Explain why each condition or operation you use is valid.

EXAM COMMUNICATION

Use one mathematical statement per line. Label units and restrictions. If the result is approximate, show the unrounded value before the final rounded answer.

COMPREHENSIVE LESSON NOTEBOOK

Independent practice

Circles, arcs and sectors

Complete without notes. Show all working, then use the answer section to diagnose and repair errors.

1. A sector radius 15 cm has area $75\pi \text{ cm}^2$. Find angle and arc length.

[5]

SHOW ALL WORKING

2. A chord subtends 90° at centre of circle radius 8 cm. Find minor segment area.

[5]

SHOW ALL WORKING

3. Find arc length of a 90° sector radius 8 cm.

[3]

4. Find area of a 60° sector radius 9 cm.

[3]

5. A circle circumference is $14\pi \text{ cm}$. Find radius.

[2]

6. Find perimeter of a semicircle radius 4 cm.

[3]

7. An annular sector angle 72° , radii 10 and 6 cm. Find area.

[4]

8. A sector arc length is 6π and angle 135° . Find radius.

[4]

REFLECTION

Circle one: secure / almost / reteach. Record the question number of your most useful error and the rule that repairs it.

COMPREHENSIVE LESSON NOTEBOOK

Prisms and volume

Find volume from cross-sectional area and length.

SPECIFICATION FOCUS

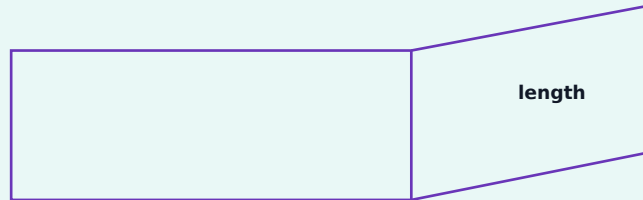
OCR reference OCR 10.04a. This lesson develops representation, accurate calculation, reasoning and interpretation within Higher Tier.

Understand the idea

A prism repeats a constant cross-section through a length. Multiplying the layer area by length counts three-dimensional space.

KEY VOCABULARY

prism • cross-section • length • volume • capacity



Why the method works

- The formula follows from the geometric structure or defining rate.
- Units track the type and scale of the result.
- An estimate or inverse calculation provides an independent check.

CHECK BEFORE MOVING ON

Answer mentally: A prism has cross-section area 42 cm^2 and length 1.8 m . Find volume in litres. Then define one key word from this page in your own words.

COMPREHENSIVE LESSON NOTEBOOK

Prisms and volume — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Use $\text{volume} = \text{cross-sectional area} \times \text{length}$.
- For cuboids use lwh .
- Make all dimensions use compatible units.

WORKED EXAMPLE 1

A prism has cross-section area 42 cm^2 and length 1.8 m . Find volume in litres.

SOLUTION

1. Length = 180 cm .
2. Volume = $42 \times 180 = 7560 \text{ cm}^3$.
3. $1000 \text{ cm}^3 = 1 \text{ L}$.

ANSWER: 7.56 L

WORKED EXAMPLE 2

A prism cross-section is a trapezium with parallel sides $5, 11 \text{ cm}$ and height 4 cm ; volume 640 cm^3 . Find length.

SOLUTION

1. Cross-section = $\frac{1}{2}(5+11)4 = 32 \text{ cm}^2$.
2. Length = $640/32$.

ANSWER: 20 cm

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes a solution easier to repair.

COMPREHENSIVE LESSON NOTEBOOK

Prisms and volume — apply and reason

Connect the method to decisions and common errors.

Where this mathematics appears

Packaging, tanks and building components use prism volumes.

Common misconceptions

- Using incompatible units.
- Selecting a visually familiar but incorrect formula.
- Rounding before the final step or omitting units.

GUIDED TRY

Triangular prism triangle base 6, height 4, length 9 cm. Find volume. First predict the form or approximate size of the answer. Then show the complete method.

REASONING PROMPT

A hollow prism has outer cross-section 12×9 and inner 8×5 cm, length 2 m. Find material volume. Explain why each condition or operation you use is valid.

EXAM COMMUNICATION

Use one mathematical statement per line. Label units and restrictions. If the result is approximate, show the unrounded value before the final rounded answer.

COMPREHENSIVE LESSON NOTEBOOK

Independent practice

Prisms and volume

Complete without notes. Show all working, then use the answer section to diagnose and repair errors.

1. A prism has cross-section area 42 cm^2 and length 1.8 m . Find volume in litres.

[4]

2. A prism cross-section is a trapezium with parallel sides $5, 11 \text{ cm}$ and height 4 cm ; volume 640 cm^3 . Find length.

[4]

3. Triangular prism triangle base 6 , height 4 , length 9 cm . Find volume.

[3]

4. A cuboid volume 360 cm^3 , base $12 \times 5 \text{ cm}$. Find height.

[3]

5. A tank $1.2 \times 0.5 \times 0.8 \text{ m}$. Find capacity in litres.

[3]

6. A prism volume 525 cm^3 and length 15 cm . Find cross-section area.

[2]

7. A cylinder volume is $500\pi \text{ cm}^3$ and height 20 cm . Find radius.

[4]

8. A hollow prism has outer cross-section 12×9 and inner $8 \times 5 \text{ cm}$, length 2 m . Find material volume.

[5]

SHOW ALL WORKING

REFLECTION

Circle one: secure / almost / reteach. Record the question number of your most useful error and the rule that repairs it.

COMPREHENSIVE LESSON NOTEBOOK

Surface area and nets

Add the areas of every exposed face.

SPECIFICATION FOCUS

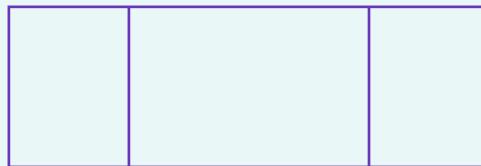
OCR reference OCR 10.04a. This lesson develops representation, accurate calculation, reasoning and interpretation within Higher Tier.

Understand the idea

Surface area totals every exposed face. A net makes those faces visible and helps prevent omissions or double counting.

KEY VOCABULARY

surface area • face • net • exposed • square unit



net: add every exposed face

Why the method works

- The formula follows from the geometric structure or defining rate.
- Units track the type and scale of the result.
- An estimate or inverse calculation provides an independent check.

CHECK BEFORE MOVING ON

Answer mentally: Find total surface area of cylinder radius 5 cm, height 12 cm. Then define one key word from this page in your own words.

COMPREHENSIVE LESSON NOTEBOOK

Surface area and nets — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Sketch or inspect a net.
- Group congruent faces.
- Exclude joined internal faces.

WORKED EXAMPLE 1

Find total surface area of cylinder radius 5 cm, height 12 cm.

SOLUTION

1. Two circles = 50π .
2. Curved area = $2\pi rh = 120\pi$.

ANSWER: $170\pi \text{ cm}^2$

WORKED EXAMPLE 2

A closed cylinder has volume $400\pi \text{ cm}^3$ and radius 5 cm. Find surface area.

SOLUTION

1. Height = $400\pi / (25\pi) = 16$.
2. Surface = $2\pi r^2 + 2\pi rh$.

ANSWER: $210\pi \text{ cm}^2$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes a solution easier to repair.

COMPREHENSIVE LESSON NOTEBOOK

Surface area and nets — apply and reason

Connect the method to decisions and common errors.

Where this mathematics appears

Wrapping, coating and material estimates use surface area.

Common misconceptions

- Using incompatible units.
- Selecting a visually familiar but incorrect formula.
- Rounding before the final step or omitting units.

GUIDED TRY

A closed triangular prism has triangle sides 3,4,5, length 10. Find surface area. First predict the form or approximate size of the answer. Then show the complete method.

REASONING PROMPT

A triangular prism has right-triangle cross-section legs 6,8 and length 15. Find surface area. Explain why each condition or operation you use is valid.

EXAM COMMUNICATION

Use one mathematical statement per line. Label units and restrictions. If the result is approximate, show the unrounded value before the final rounded answer.

COMPREHENSIVE LESSON NOTEBOOK

Independent practice

Surface area and nets

Complete without notes. Show all working, then use the answer section to diagnose and repair errors.

1. Find total surface area of cylinder radius 5 cm, height 12 cm.

[4]

2. A closed cylinder has volume $400\pi \text{ cm}^3$ and radius 5 cm. Find surface area.

[5]

SHOW ALL WORKING

3. A closed triangular prism has triangle sides 3,4,5, length 10. Find surface area.

[4]

4. A cube surface area is 216 cm^2 . Find side.

[3]

5. An open-top $10 \times 6 \times 4 \text{ cm}$ box. Find surface area.

[3]

6. How many rectangles appear in a triangular-prism net?

[1]

7. A cuboid $3 \times 4 \times 12$ has space diagonal 13. Prove.

[4]

8. A triangular prism has right-triangle cross-section legs 6,8 and length 15. Find surface area.

[5]

SHOW ALL WORKING

REFLECTION

Circle one: secure / almost / reteach. Record the question number of your most useful error and the rule that repairs it.

COMPREHENSIVE LESSON NOTEBOOK

Cones, spheres and pyramids

Use supplied solid formulae and distinguish perpendicular from slant height.

SPECIFICATION FOCUS

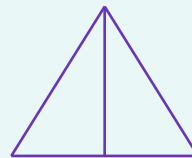
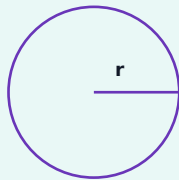
OCR reference OCR 10.04b-10.04c. This lesson develops representation, accurate calculation, reasoning and interpretation within Higher Tier.

Understand the idea

Curved solids and pyramids use supplied formulae. Perpendicular height measures direct separation; slant height lies on a surface.

KEY VOCABULARY

sphere • cone • pyramid • perpendicular height • slant height



sphere radius • pyramid perpendicular height

Why the method works

- The formula follows from the geometric structure or defining rate.
- Units track the type and scale of the result.
- An estimate or inverse calculation provides an independent check.

CHECK BEFORE MOVING ON

Answer mentally: A cone radius 6 cm, height 8 cm. Find exact volume and total surface area. Then define one key word from this page in your own words.

COMPREHENSIVE LESSON NOTEBOOK

Cones, spheres and pyramids — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Copy the supplied formula before substituting.
- Use perpendicular height for volume; use slant height only where a surface-area formula requires it.
- Keep pi until the final rounding step.

WORKED EXAMPLE 1

A cone radius 6 cm, height 8 cm. Find exact volume and total surface area.

SOLUTION

1. Slant height=10.
2. Volume= $\frac{1}{3}\pi \times 36 \times 8$.
3. Surface= $\pi r^2 + \pi rl$.

ANSWER: $96\pi \text{ cm}^3$ and $96\pi \text{ cm}^2$

WORKED EXAMPLE 2

A sphere volume is $288\pi \text{ cm}^3$. Find radius and surface area.

SOLUTION

1. $\frac{4}{3}\pi r^3 = 288\pi$ gives $r^3 = 216$.
2. Use $4\pi r^2$.

ANSWER: $r=6 \text{ cm}$; area= $144\pi \text{ cm}^2$

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes a solution easier to repair.

COMPREHENSIVE LESSON NOTEBOOK

Cones, spheres and pyramids — apply and reason

Connect the method to decisions and common errors.

Where this mathematics appears

Packaging, storage and engineering use volumes and surface areas of solids.

Common misconceptions

- Using incompatible units.
- Selecting a visually familiar but incorrect formula.
- Rounding before the final step or omitting units.

GUIDED TRY

A pyramid has base area 30 cm^2 and perpendicular height 8 cm . Find its volume. First predict the form or approximate size of the answer. Then show the complete method.

REASONING PROMPT

A hemisphere radius 4 cm is joined to cylinder radius 4 , height 9 . Find exact volume. Explain why each condition or operation you use is valid.

EXAM COMMUNICATION

Use one mathematical statement per line. Label units and restrictions. If the result is approximate, show the unrounded value before the final rounded answer.

COMPREHENSIVE LESSON NOTEBOOK

Independent practice

Cones, spheres and pyramids

Complete without notes. Show all working, then use the answer section to diagnose and repair errors.

1. A cone radius 6 cm, height 8 cm. Find exact volume and total surface area.

[5]

SHOW ALL WORKING

2. A sphere volume is $288\pi \text{ cm}^3$. Find radius and surface area.

[5]

SHOW ALL WORKING

3. A pyramid has base area 30 cm^2 and perpendicular height 8 cm. Find its volume.

[3]

4. A sphere has radius 5 cm. Use $A=4\pi r^2$ to find surface area in terms of π .

[3]

5. A cone has radius 3 cm and slant height 7 cm. Use curved area $=\pi rl$.

[2]

6. Why is the cone height in its volume formula perpendicular?

[2]

7. A square-based pyramid base side 10 cm, vertical height 12 cm. Find volume.

[3]

8. A hemisphere radius 4 cm is joined to cylinder radius 4, height 9. Find exact volume.

[5]

SHOW ALL WORKING

REFLECTION

Circle one: secure / almost / reteach. Record the question number of your most useful error and the rule that repairs it.

COMPREHENSIVE LESSON NOTEBOOK

3D Pythagoras and trigonometry

Solve complex 2D and 3D right-triangle problems and use exact trigonometric values.

SPECIFICATION FOCUS

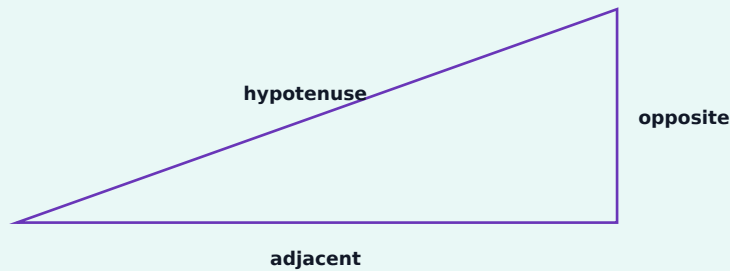
OCR reference OCR 10.05a–10.05c. This lesson develops representation, accurate calculation, reasoning and interpretation within Higher Tier.

Understand the idea

Three-dimensional problems hide right triangles across faces and through solids. Construct the relevant 2D cross-section, then use Pythagoras or a trigonometric ratio with clearly identified opposite, adjacent and hypotenuse sides.

KEY VOCABULARY

Pythagoras • hypotenuse • sine • cosine • tangent • exact value • 3D



Why the method works

- Pythagoras follows from squared length relationships.
- Trig ratios depend only on angle in similar right triangles.
- Exact special-angle values come from equilateral and isosceles right triangles.

CHECK BEFORE MOVING ON

Answer mentally: Cuboid dimensions 4,7,10 cm. Find space diagonal. Then define one key word from this page in your own words.

COMPREHENSIVE LESSON NOTEBOOK

3D Pythagoras and trigonometry — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Draw and label the right triangle being used.
- Use Pythagoras for two known sides; trig for an angle-side relationship.
- Keep exact surds and trig values until approximation is requested.

WORKED EXAMPLE 1

Cuboid dimensions 4,7,10 cm. Find space diagonal.

SOLUTION

1. Square diagonal = $4^2 + 7^2 + 10^2$.
2. Take square root.

ANSWER: $\sqrt{165}$ cm

WORKED EXAMPLE 2

A vertical mast 18 m has cable 24 m. Find angle cable makes with ground.

SOLUTION

1. $\sin \theta = 18/24$.
2. $\theta = \sin^{-1}(0.75)$.

ANSWER: about 48.6°

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes a solution easier to repair.

COMPREHENSIVE LESSON NOTEBOOK

3D Pythagoras and trigonometry — apply and reason

Connect the method to decisions and common errors.

Where this mathematics appears

Surveying, construction and navigation use right-triangle models in space.

Common misconceptions

- Using a face diagonal instead of space diagonal.
- Choosing sides before marking the angle.
- Rounding an intermediate diagonal.

GUIDED TRY

Find exact value $6\sin 30^\circ + 4\cos 60^\circ$. First predict the form or approximate size of the answer. Then show the complete method.

REASONING PROMPT

Explain why $\sin^2\theta + \cos^2\theta = 1$ using a right triangle. Explain why each condition or operation you use is valid.

EXAM COMMUNICATION

Use one mathematical statement per line. Label units and restrictions. If the result is approximate, show the unrounded value before the final rounded answer.

COMPREHENSIVE LESSON NOTEBOOK

Independent practice

3D Pythagoras and trigonometry

Complete without notes. Show all working, then use the answer section to diagnose and repair errors.

1. Cuboid dimensions 4,7,10 cm. Find space diagonal.

[4]

2. A vertical mast 18 m has cable 24 m. Find angle cable makes with ground.

[4]

3. Find exact value $6\sin 30^\circ + 4\cos 60^\circ$.

[3]

4. Find exact $\tan 45^\circ \times \cos 30^\circ$.

[3]

5. A cuboid $8 \times 6 \times 5$. Find angle space diagonal makes with base.

[5]

SHOW ALL WORKING

6. A cone radius 5, height 12. Find slant height and angle at apex between axis and side.

[5]

SHOW ALL WORKING

7. A ladder reaches 5.4 m high at angle 68° . Find ladder length.

[4]

8. Explain why $\sin^2 \theta + \cos^2 \theta = 1$ using a right triangle.

[4]

REFLECTION

Circle one: secure / almost / reteach. Record the question number of your most useful error and the rule that repairs it.

COMPREHENSIVE LESSON NOTEBOOK

Sine rule, cosine rule and mixed triangles

Solve non-right-angled triangles and select an efficient rule.

SPECIFICATION FOCUS

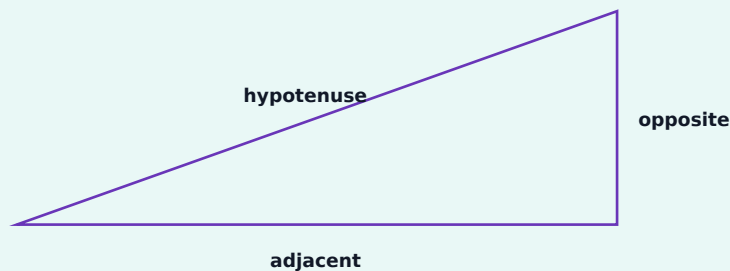
OCR reference OCR 10.05d–10.05e. This lesson develops representation, accurate calculation, reasoning and interpretation within Higher Tier.

Understand the idea

Non-right-angled triangles require general rules. The sine rule uses opposite angle-side pairs; cosine rule extends Pythagoras and is effective for SAS or SSS data.

KEY VOCABULARY

sine rule • cosine rule • included angle • opposite pair • ambiguous case



Why the method works

- Sine rule follows from equal expressions for twice the area.
- Cosine rule reduces to Pythagoras at 90° .
- The sine function can produce two angles in 0° to 180° .

CHECK BEFORE MOVING ON

Answer mentally: In triangle ABC, $a=9$, $A=38^\circ$, $B=71^\circ$. Find b . Then define one key word from this page in your own words.

COMPREHENSIVE LESSON NOTEBOOK

Sine rule, cosine rule and mixed triangles — method and examples

Follow the reasoning; do not copy steps mechanically.

Reliable method

- Use sine rule with a known opposite pair.
- Use cosine rule for SAS or SSS data.
- Check ambiguous sine-rule angles against the diagram and triangle sum.

WORKED EXAMPLE 1

In triangle ABC, $a=9$, $A=38^\circ$, $B=71^\circ$. Find b .

SOLUTION

1. $b/\sin 71 = 9/\sin 38$.
2. Solve.

ANSWER: about 13.8

WORKED EXAMPLE 2

Sides 7 and 11 include angle 64° . Find third side.

SOLUTION

1. $c^2 = 7^2 + 11^2 - 2 \times 7 \times 11 \cos 64^\circ$.
2. Take square root.

ANSWER: about 10.0

SELF-CHECK QUESTION

Which step carries the mathematical reason, and which step carries only arithmetic? Being able to distinguish them makes a solution easier to repair.

COMPREHENSIVE LESSON NOTEBOOK

Sine rule, cosine rule and mixed triangles — apply and reason

Connect the method to decisions and common errors.

Where this mathematics appears

Bearings, triangulation and indirect distances use general triangle mensuration.

Common misconceptions

- Pairing a side with the wrong angle.
- Using a non-included angle in cosine rule SAS.
- Ignoring the ambiguous sine case.

GUIDED TRY

Sides are 8,10,13. Find angle opposite 13. First predict the form or approximate size of the answer. Then show the complete method.

REASONING PROMPT

Triangle has $A=52^\circ$, $B=63^\circ$, $a=14$. Find c . Explain why each condition or operation you use is valid.

EXAM COMMUNICATION

Use one mathematical statement per line. Label units and restrictions. If the result is approximate, show the unrounded value before the final rounded answer.

COMPREHENSIVE LESSON NOTEBOOK

Independent practice

Sine rule, cosine rule and mixed triangles

Complete without notes. Show all working, then use the answer section to diagnose and repair errors.

1. In triangle ABC, $a=9$, $A=38^\circ$, $B=71^\circ$. Find b .

[4]

2. Sides 7 and 11 include angle 64° . Find third side.

[4]

3. Sides are 8,10,13. Find angle opposite 13.

[5]

SHOW ALL WORKING

4. A triangle has $A=30^\circ$, $a=6$, $b=10$. Find possible B values.

[5]

SHOW ALL WORKING

5. Find area with sides 12,17 and included angle 43° .

[3]

6. A ship travels 18 km then 25 km with included turn angle 112° . Find direct distance.

[4]

7. Why is cosine rule appropriate for three known sides?

[3]

8. Triangle has $A=52^\circ$, $B=63^\circ$, $a=14$. Find c .

[4]

REFLECTION

Circle one: secure / almost / reteach. Record the question number of your most useful error and the rule that repairs it.

COMPREHENSIVE LESSON NOTEBOOK

Practice answers and repair notes

Units and measurement

Use only after a genuine attempt. Rework incorrect questions from a blank line rather than copying the final value.

1. Convert 3.7 m^2 to mm^2 .

ANSWER: $3,700,000 \text{ mm}^2$

Method cue: $1 \text{ m} = 1000 \text{ mm}$. Check sign, size, accuracy and units.

2. A cube has volume 0.064 m^3 . Find its side length in cm.

ANSWER: 40 cm

Method cue: Cube root $0.064 = 0.4 \text{ m}$. Check sign, size, accuracy and units.

3. Convert 2.4 m^2 to cm^2 .

ANSWER: $24,000 \text{ cm}^2$

Method cue: $1 \text{ m}^2 = 10,000 \text{ cm}^2$. Check sign, size, accuracy and units.

4. Convert 0.035 m^3 to litres.

ANSWER: 35 litres

Method cue: $1 \text{ m}^3 = 1000 \text{ L}$. Check sign, size, accuracy and units.

5. Convert 2.75 kg to grams.

ANSWER: 2750 g

Method cue: Multiply by 1000. Check sign, size, accuracy and units.

6. Convert 2 h 45 min to minutes.

ANSWER: 165 minutes

Method cue: $2 \text{ h} = 120 \text{ min}$. Check sign, size, accuracy and units.

7. Convert 2.85 g/cm^3 to kg/m^3 .

ANSWER: 2850 kg/m^3

Method cue: $1 \text{ g} = 0.001 \text{ kg}$ and $1 \text{ cm}^3 = 10^{-6} \text{ m}^3$. Check sign, size, accuracy and units.

8. A speed is 17.5 m/s . Convert to km/h.

ANSWER: 63 km/h

Method cue: Multiply by 3.6. Check sign, size, accuracy and units.

COMPREHENSIVE LESSON NOTEBOOK

Practice answers and repair notes

Compound units, maps and scales

Use only after a genuine attempt. Rework incorrect questions from a blank line rather than copying the final value.

1. A car travels 186 km in 2 h 15 min. Find average speed in m/s.

ANSWER: 22.96 m/s

Method cue: Time=2.25 h. Check sign, size, accuracy and units.

2. A metal block 12 cm by 8 cm by 5 cm has mass 3.744 kg. Find density in g/cm³.

ANSWER: 7.8 g/cm³

Method cue: Volume=480 cm³. Check sign, size, accuracy and units.

3. A map scale is 1:50,000. What does 4 cm represent?

ANSWER: 2 km

Method cue: Real=4×50,000=200,000 cm. Check sign, size, accuracy and units.

4. A car travels 72 km/h for 25 min. Find distance.

ANSWER: 30 km

Method cue: 25 min=25/60 h. Check sign, size, accuracy and units.

5. Flow rate is 18 L/min for 7.5 min. Find volume.

ANSWER: 135 L

Method cue: 18×7.5=135. Check sign, size, accuracy and units.

6. A real wall 12 m is 8 cm on a plan. Find scale.

ANSWER: 1:150

Method cue: 12 m=1200 cm. Check sign, size, accuracy and units.

7. A map scale is 1:25,000. An area is 18 cm² on map. Find real area in hectares.

ANSWER: 112.5 hectares

Method cue: Area factor=25000². Check sign, size, accuracy and units.

8. A force 3.6 kN acts on 24 cm². Find pressure in Pa.

ANSWER: 1,500,000 Pa

Method cue: Force=3600 N. Check sign, size, accuracy and units.

COMPREHENSIVE LESSON NOTEBOOK

Practice answers and repair notes

Perimeter and compound boundaries

Use only after a genuine attempt. Rework incorrect questions from a blank line rather than copying the final value.

1. A stadium track consists of two semicircles radius 36.5 m and two straights 84.4 m. Find...

ANSWER: about 398.1 m

Method cue: Two semicircles form one circle. Check sign, size, accuracy and units.

2. A sector radius 12 cm has perimeter 39 cm. Find its angle.

ANSWER: about 71.6°

Method cue: Arc length = $39 - 24 = 15$ cm. Check sign, size, accuracy and units.

3. Triangle sides are 7.2, 8.5, 10.1 cm. Find perimeter.

ANSWER: 25.8 cm

Method cue: Add all three sides. Check sign, size, accuracy and units.

4. An L-shape comes from 10×8 rectangle with 4×3 corner removed. Find perimeter.

ANSWER: 36 cm

Method cue: Corner removal replaces equal horizontal and vertical lengths. Check sign, size, accuracy and units.

5. A regular hexagon side is 6.5 cm. Find perimeter.

ANSWER: 39 cm

Method cue: $6 \times 6.5 = 39$. Check sign, size, accuracy and units.

6. A semicircle has diameter 10 cm. Find total perimeter to 1 d.p.

ANSWER: 25.7 cm

Method cue: Half circumference = 5π . Check sign, size, accuracy and units.

7. A regular hexagon side 9 cm is combined with a semicircle on one side. Find external per...

ANSWER: $45 + 4.5\pi$ cm

Method cue: Five hexagon sides remain. Check sign, size, accuracy and units.

8. A wheel radius 0.42 m turns 850 times. Find distance in km.

ANSWER: about 2.24 km

Method cue: Distance = $850 \times 2\pi \times 0.42$ m. Check sign, size, accuracy and units.

COMPREHENSIVE LESSON NOTEBOOK

Practice answers and repair notes

Area of polygons and compound shapes

Use only after a genuine attempt. Rework incorrect questions from a blank line rather than copying the final value.

1. Find area of triangle with sides 9 cm and 14 cm and included angle 38° .

ANSWER: about 38.8 cm^2

Method cue: Use $\frac{1}{2} ab \sin C$. Check sign, size, accuracy and units.

2. A trapezium area is 156 cm^2 , parallel sides 9 and 17 cm. Find perpendicular height.

ANSWER: 12 cm

Method cue: $156 = \frac{1}{2}(26)h$. Check sign, size, accuracy and units.

3. Find parallelogram area base 11 cm, height 4.5 cm.

ANSWER: 49.5 cm^2

Method cue: $11 \times 4.5 = 49.5$. Check sign, size, accuracy and units.

4. Find trapezium area with parallel sides 8 and 14 cm, height 5 cm.

ANSWER: 55 cm^2

Method cue: $\frac{1}{2}(8+14) \times 5 = 55$. Check sign, size, accuracy and units.

5. A 10×8 rectangle has 3×2 cut-out. Find remaining area.

ANSWER: 74 cm^2

Method cue: $80 - 6 = 74$. Check sign, size, accuracy and units.

6. A triangle area is 48 cm^2 and base 12 cm. Find height.

ANSWER: 8 cm

Method cue: $48 = \frac{1}{2} \times 12 \times h = 6h$. Check sign, size, accuracy and units.

7. A square of side 14 cm contains four quarter-circles radius 7 cm at corners. Find uncove...

ANSWER: $196 - 49\pi \text{ cm}^2$

Method cue: Four quarters form one circle radius 7. Check sign, size, accuracy and units.

8. A regular hexagon has side 8 cm. Find exact area.

ANSWER: $96\sqrt{3} \text{ cm}^2$

Method cue: Split into six equilateral triangles. Check sign, size, accuracy and units.

COMPREHENSIVE LESSON NOTEBOOK

Practice answers and repair notes

Circles, arcs and sectors

Use only after a genuine attempt. Rework incorrect questions from a blank line rather than copying the final value.

1. A sector radius 15 cm has area $75\pi \text{ cm}^2$. Find angle and arc length.

ANSWER: 120° and $10\pi \text{ cm}$

Method cue: $\theta/360 \times 225\pi = 75\pi$ gives $\theta = 120$. Check sign, size, accuracy and units.

2. A chord subtends 90° at centre of circle radius 8 cm. Find minor segment area.

ANSWER: $16\pi - 32 \text{ cm}^2$

Method cue: Sector area $= 90/360 \times 64\pi = 16\pi$. Check sign, size, accuracy and units.

3. Find arc length of a 90° sector radius 8 cm.

ANSWER: $4\pi \text{ cm} \approx 12.6 \text{ cm}$

Method cue: $90/360 \times 2\pi \times 8 = 4\pi$. Check sign, size, accuracy and units.

4. Find area of a 60° sector radius 9 cm.

ANSWER: $13.5\pi \text{ cm}^2 \approx 42.4 \text{ cm}^2$

Method cue: $60/360 \times \pi \times 9^2 = 13.5\pi$. Check sign, size, accuracy and units.

5. A circle circumference is $14\pi \text{ cm}$. Find radius.

ANSWER: 7 cm

Method cue: $2\pi r = 14\pi$, so $r = 7$. Check sign, size, accuracy and units.

6. Find perimeter of a semicircle radius 4 cm.

ANSWER: $8 + 4\pi \text{ cm} \approx 20.6 \text{ cm}$

Method cue: Half circumference $= 4\pi$. Check sign, size, accuracy and units.

7. An annular sector angle 72° , radii 10 and 6 cm. Find area.

ANSWER: $12.8\pi \text{ cm}^2$

Method cue: Fraction $= 72/360 = 1/5$. Check sign, size, accuracy and units.

8. A sector arc length is 6π and angle 135° . Find radius.

ANSWER: 8 cm

Method cue: $6\pi = 135/360 \times 2\pi r$. Check sign, size, accuracy and units.

COMPREHENSIVE LESSON NOTEBOOK

Practice answers and repair notes

Prisms and volume

Use only after a genuine attempt. Rework incorrect questions from a blank line rather than copying the final value.

1. A prism has cross-section area 42 cm^2 and length 1.8 m . Find volume in litres.

ANSWER: 7.56 L

Method cue: Length= 180 cm . Check sign, size, accuracy and units.

2. A prism cross-section is a trapezium with parallel sides $5, 11 \text{ cm}$ and height 4 cm ; volume...

ANSWER: 20 cm^3

Method cue: Cross-section= $\frac{1}{2}(5+11)4=32 \text{ cm}^2$. Check sign, size, accuracy and units.

3. Triangular prism triangle base 6 , height 4 , length 9 cm . Find volume.

ANSWER: 108 cm^3

Method cue: Triangle area= 12 cm^2 . Check sign, size, accuracy and units.

4. A cuboid volume 360 cm^3 , base $12 \times 5 \text{ cm}$. Find height.

ANSWER: 6 cm

Method cue: Base area= 60 . Check sign, size, accuracy and units.

5. A tank $1.2 \times 0.5 \times 0.8 \text{ m}$. Find capacity in litres.

ANSWER: 480 litres

Method cue: Volume= 0.48 m^3 . Check sign, size, accuracy and units.

6. A prism volume 525 cm^3 and length 15 cm . Find cross-section area.

ANSWER: 35 cm^2

Method cue: $525 \div 15 = 35$. Check sign, size, accuracy and units.

7. A cylinder volume is $500\pi \text{ cm}^3$ and height 20 cm . Find radius.

ANSWER: 5 cm

Method cue: $\pi r^2 h = 500\pi$. Check sign, size, accuracy and units.

8. A hollow prism has outer cross-section 12×9 and inner $8 \times 5 \text{ cm}$, length 2 m . Find material ...

ANSWER: $13,600 \text{ cm}^3$

Method cue: Cross-sectional material area= $108 - 40 = 68$. Check sign, size, accuracy and units.

COMPREHENSIVE LESSON NOTEBOOK

Practice answers and repair notes

Surface area and nets

Use only after a genuine attempt. Rework incorrect questions from a blank line rather than copying the final value.

1. Find total surface area of cylinder radius 5 cm, height 12 cm.

ANSWER: $170\pi \text{ cm}^2$

Method cue: Two circles= 50π . Check sign, size, accuracy and units.

2. A closed cylinder has volume $400\pi \text{ cm}^3$ and radius 5 cm. Find surface area.

ANSWER: $210\pi \text{ cm}^2$

Method cue: Height= $400\pi/(25\pi)=16$. Check sign, size, accuracy and units.

3. A closed triangular prism has triangle sides 3,4,5, length 10. Find surface area.

ANSWER: 132 cm^2

Method cue: Two triangles: $2 \times 6 = 12$. Check sign, size, accuracy and units.

4. A cube surface area is 216 cm^2 . Find side.

ANSWER: 6 cm

Method cue: One face= $216 \div 6 = 36 \text{ cm}^2$. Check sign, size, accuracy and units.

5. An open-top $10 \times 6 \times 4 \text{ cm}$ box. Find surface area.

ANSWER: 188 cm^2

Method cue: Base=60. Check sign, size, accuracy and units.

6. How many rectangles appear in a triangular-prism net?

ANSWER: 3

Method cue: One for each side of the triangular cross-section. Check sign, size, accuracy and units.

7. A cuboid $3 \times 4 \times 12$ has space diagonal 13. Prove.

ANSWER: $\sqrt{3^2+4^2+12^2}=13$

Method cue: Use 3D Pythagoras. Check sign, size, accuracy and units.

8. A triangular prism has right-triangle cross-section legs 6,8 and length 15. Find surface...

ANSWER: 408 cm^2

Method cue: Triangle pair=48. Check sign, size, accuracy and units.

COMPREHENSIVE LESSON NOTEBOOK

Practice answers and repair notes

Cones, spheres and pyramids

Use only after a genuine attempt. Rework incorrect questions from a blank line rather than copying the final value.

1. A cone radius 6 cm, height 8 cm. Find exact volume and total surface area.

ANSWER: $96\pi \text{ cm}^3$ and $96\pi \text{ cm}^2$

Method cue: Slant height=10. Check sign, size, accuracy and units.

2. A sphere volume is $288\pi \text{ cm}^3$. Find radius and surface area.

ANSWER: $r=6 \text{ cm}$; $\text{area}=144\pi \text{ cm}^2$

Method cue: $\frac{4}{3}\pi r^3=288\pi$ gives $r^3=216$. Check sign, size, accuracy and units.

3. A pyramid has base area 30 cm^2 and perpendicular height 8 cm. Find its volume.

ANSWER: 80 cm^3

Method cue: $V=\frac{1}{3}\times\text{base area}\times\text{height}$. Check sign, size, accuracy and units.

4. A sphere has radius 5 cm. Use $A=4\pi r^2$ to find surface area in terms of π .

ANSWER: $100\pi \text{ cm}^2$

Method cue: $A=4\pi\times 25$. Check sign, size, accuracy and units.

5. A cone has radius 3 cm and slant height 7 cm. Use curved area= πrl .

ANSWER: $21\pi \text{ cm}^2$

Method cue: $\pi\times 3\times 7=21\pi$. Check sign, size, accuracy and units.

6. Why is the cone height in its volume formula perpendicular?

ANSWER: Volume depends on the shortest distance from base to vertex.

Method cue: A slant length is not the layer separation. Check sign, size, accuracy and units.

7. A square-based pyramid base side 10 cm, vertical height 12 cm. Find volume.

ANSWER: 400 cm^3

Method cue: Use $\frac{1}{3}\times 100\times 12$. Check sign, size, accuracy and units.

8. A hemisphere radius 4 cm is joined to cylinder radius 4, height 9. Find exact volume.

ANSWER: $(560/3)\pi \text{ cm}^3$

Method cue: Cylinder= $144\pi=432\pi/3$. Check sign, size, accuracy and units.

COMPREHENSIVE LESSON NOTEBOOK

Practice answers and repair notes

3D Pythagoras and trigonometry

Use only after a genuine attempt. Rework incorrect questions from a blank line rather than copying the final value.

1. Cuboid dimensions 4,7,10 cm. Find space diagonal.

ANSWER: $\sqrt{165}$ cm

Method cue: Square diagonal= $4^2+7^2+10^2$. Check sign, size, accuracy and units.

2. A vertical mast 18 m has cable 24 m. Find angle cable makes with ground.

ANSWER: about 48.6°

Method cue: $\sin\theta=18/24$. Check sign, size, accuracy and units.

3. Find exact value $6\sin 30^\circ+4\cos 60^\circ$.

ANSWER: 5

Method cue: $\sin 30=\cos 60=1/2$. Check sign, size, accuracy and units.

4. Find exact $\tan 45^\circ \times \cos 30^\circ$.

ANSWER: $\sqrt{3}/2$

Method cue: $\tan 45=1$; $\cos 30=\sqrt{3}/2$. Check sign, size, accuracy and units.

5. A cuboid $8\times 6\times 5$. Find angle space diagonal makes with base.

ANSWER: about 26.6°

Method cue: Base diagonal=10. Check sign, size, accuracy and units.

6. A cone radius 5, height 12. Find slant height and angle at apex between axis and side.

ANSWER: 13 cm; about 22.6°

Method cue: Pythagoras gives 13. Check sign, size, accuracy and units.

7. A ladder reaches 5.4 m high at angle 68° . Find ladder length.

ANSWER: about 5.82 m

Method cue: $\sin 68=5.4/L$. Check sign, size, accuracy and units.

8. Explain why $\sin^2\theta+\cos^2\theta=1$ using a right triangle.

ANSWER: divide Pythagoras by hypotenuse²

Method cue: $\text{opp}^2+\text{adj}^2=\text{hyp}^2$. Check sign, size, accuracy and units.

COMPREHENSIVE LESSON NOTEBOOK

Practice answers and repair notes

Sine rule, cosine rule and mixed triangles

Use only after a genuine attempt. Rework incorrect questions from a blank line rather than copying the final value.

1. In triangle ABC, $a=9$, $A=38^\circ$, $B=71^\circ$. Find b .

ANSWER: about 13.8

Method cue: $b/\sin 71 = 9/\sin 38$. Check sign, size, accuracy and units.

2. Sides 7 and 11 include angle 64° . Find third side.

ANSWER: about 10.0

Method cue: $c^2 = 7^2 + 11^2 - 2 \times 7 \times 11 \cos 64^\circ$. Check sign, size, accuracy and units.

3. Sides are 8,10,13. Find angle opposite 13.

ANSWER: about 94.1°

Method cue: $\cos C = (8^2 + 10^2 - 13^2) / (2 \times 8 \times 10)$. Check sign, size, accuracy and units.

4. A triangle has $A=30^\circ$, $a=6$, $b=10$. Find possible B values.

ANSWER: about 56.4° or 123.6°

Method cue: $\sin B = 10 \sin 30 / 6 = 5/6$. Check sign, size, accuracy and units.

5. Find area with sides 12,17 and included angle 43° .

ANSWER: about 69.6

Method cue: $\text{Area} = 1/2 \times 12 \times 17 \sin 43^\circ$. Check sign, size, accuracy and units.

6. A ship travels 18 km then 25 km with included turn angle 112° . Find direct distance.

ANSWER: about 35.8 km

Method cue: Use cosine rule with included angle. Check sign, size, accuracy and units.

7. Why is cosine rule appropriate for three known sides?

ANSWER: it relates one angle to all three sides without an opposite angle-side pair

Method cue: Rearrange for $\cos C$. Check sign, size, accuracy and units.

8. Triangle has $A=52^\circ$, $B=63^\circ$, $a=14$. Find c .

ANSWER: about 16.1

Method cue: $C = 65^\circ$. Check sign, size, accuracy and units.

COMPREHENSIVE LESSON NOTEBOOK

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- Original vector diagrams and two worked examples appear in every chapter.
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- Answers are collected at the end with method cues.
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